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(54) [TITLE OF THE INVENTION]
Method of manufacturing filter[s]

(57) [ABSTRACT]

[PURPOSE]
To offer a method of manufacturing filters which can be reused and show abundant water repellency and oil repellency.

[CONSTITUTION]
Method of manufacturing filter[s] that is conducted by arranging a three-dimensional mesh-form porous material having through pores between metal electrodes to which a solid dielectric is arranged on at least one opposing plane, and by applying voltage to opposing electrodes under 100 ~ 800 Torr pressure in an atmosphere of gas mixture comprising fluorine containing gas with 0.01 ~ 10 volume % and inert gas with 99.99 ~ 90 volume % to generate discharging plasma and by contacting this with above-explained three-dimensional mesh-form porous material to convert a back-bone structure surface of above-explained three-dimensional mesh-form porous body to fluorine.

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[Amendments: There are no amendments attached to this patent.]

[note: All names, addresses, company names, and brand names are translated in the most common manner. The Japanese language does not have singular or plural words unless otherwise specified with a numeral prefix or a general form of plurality suffix. Translator's note]

[CLAIMS]

[CLAIM ITEM 1]

A method of manufacturing filter[s] have characteristics as such that a three-dimensional mesh-form porous material with through pores is arranged between metal electrodes to which a solid dielectric is arranged on at the least one opposing plane, and voltage is applied to opposing electrodes under 100 ~ 800 Torr pressure in an atmosphere of gas mixture comprising fluorine containing gas with 0.01 ~ 10 volume % and inert gas with 99.99 ~ 90 volume % to generate discharge plasma, and contacting this with said three-dimensional mesh-form porous material to convert its back bone surface to fluorine.

[CLAIM ITEM 2]

The method of manufacturing filter[s] according to the claim item 1, wherein said three-dimensional mesh-form porous material being polyolefin group resin.

[DETAILED EXPLANATION OF THE INVENTION]

[0001]

[FIELDS OF INDUSTRIAL APPLICATION]

This invention relates to the method of manufacturing filter[s] capable of reuse with easy removal of dirt through washing . In further detail, this invention relates to the method of manufacturing filter[s] which are attached to ventilation system parts.

[0002]

[PRIOR ART]

Interest and demands toward ventilation are showing much increase in recent years; and popularity of ventilation device is becoming ever so strong. The ventilation device is installed at the locations where oil soot generates such as kitchen, or ventilation vent port and the like; and filter attachment type has been the main stream as its purpose is to prevent from attachment dirt on machinery and equipment caused by oil soot and to prevent from involvement of dirt and dust.

[0003]

As this type of filter for ventilation device, the filter that is formed of a nonwoven cloth that is prepared by such measure as knitting fibers of polyester and the like with nearly uniform roughness has been generally used. For instance, according to the Japanese Patent Application Kokai Hei 6[1994]-63328 publication, a technology that uses a filter comprising laminated nonwoven cloth with varied stitch roughness for purpose of improved collecting efficiency of oil has been disclosed; and when a large amount of dirt is adhered to such type of filter, it is necessary to replace this with a new filter without possible reuse.

[0004]

According to the Japanese Utility Model Application Kokai Sho 56[1981]-66731 publication, it discloses a technology that makes it difficult for dirt to adhere by covering the filter with a water repellent material to enables less frequencies of replacement of filters and in addition, with possible reuse by washing this filter.

[0005]

However, when an entire back bone surface of porous base material is covered with water repellent materials such as fluorine resin, silicon group resin, rubber, or polyethylene and the like, it is difficult to cover porous base material with high density , and is also difficult to provide a uniform cover; and therefore, clogging on the filter may occur to present problems of causing ill-affect on the filter function or present concern over changes which may occur on the three-dimensional mesh-form structure of the porous base material.

[0006]

[SUBJECTS SOLVED BY THIS INVENTION]

Based on above-explained circumstance, this invention's purpose is to offer a method of manufacturing filter[s] that can be reused and show abundant level of water repellency and oil repellency.

[MEASURES USED TO SOLVE THE SUBJECTS]

The gist of this invention lies on manufacturing of filters by placing a three-dimensional mesh-form porous material with through pores between metal electrodes of which a solid dielectric is arranged on at the least one opposing plane, and by applying voltage to opposing electrodes under 100 ~ 800 Torr pressure in an atmosphere of gas mixture comprising fluorine containing gas with 0.01 ~ 10 volume % and inert gas with 99.99 ~ 90 volume % to generate discharging plasma and by contacting this with said three-dimensional mesh-form porous material to convert a back bone surface of said three-dimensional mesh-form porous material to fluorine.

[0008]

The base material of the filter that is used in this invention is a three-dimensional mesh-form material having through voids. As above-explained three-dimensional mesh-form porous material, the ones which are prepared by knitting fibers or the one that is molded to form a nonwoven cloth may be used. As for the materials for above-explained three-dimensional mesh-form porous material, for instance, organic polymer compounds, metals, or ceramic and the like may be mentioned; and in particular, organic polymer compounds are recommended from the standpoint of softness and easy workability. As above-explained organic polymer compounds, for instance, polyolefin group resin, or polyester group resin and the like may be mentioned; and in particular, polyolefin group resins such as polyethylene or polypropylene and the like are recommended. Regarding the thickness of above-explained three-dimensional mesh-form porous material, although it may be appropriately determined based on applications, no particular restrictions are placed providing that can be inserted between opposing electrodes.

[0009]

As for the fluorine containing gas that is used in this invention, for instance, hydrocarbon fluorides gas such as methane tetrafluoride (CF_4), ethane hexafluoride (C_2F_6), or propylene hexafluoride (C_3F_6); hydrocarbon halide gas such as methane trifluoro monochloride gas (CC_1F_3) and the like; or sulfur fluoride compound such as sulfur hexafluoride (SF_6) may be mentioned; and in particular, use of methane tetrafluoride, ethane hexafluoride, or propylene hexafluoride and the like is recommended from the standpoint of no toxic gas generation and safety.

[0010]

As for the inert gas that is used in this invention, for instance, rare gas such as helium, neon, argon, or xenon and the like may ; and nitrogen gas and the like may be mentioned; and in particular, helium gas that is useful in excitation of fluorine containing gas and shows long life in a metastable state is recommended. The above-explained inert gas may be used either alone or as gas mixture. When using gas other than helium as above-explained inert gas, it is recommended to mix at the most 2 volume % of vapor gas such as acetone gas or methanol and the like; and hydrogen carbide gas such as methane or ethane and the like.

[0011]

Above-explained fluorine containing gas is excited by above-explained inert gas; and by contacting this with above-explained three-dimensional mesh-form porous material, $-CF_x$ group (X shows 1,2,or 3) or containing carbon film and the like is firmly formed on the backbone surface of above-explained three-dimensional mesh-form porous material to convert said surface to fluorine. The thickness of fluorinated layer varies according to the fluorine containing gas that is used; and it is preferable when it is about 20 ~ 1000 A.

[0012]
Mixing ratio of above-explain d fluorine containing gas and above-explained inert gas may be determined appropriately in accordance with the type of gas used; and concentration of above-explained fluorine containing gas is 0.01 ~ 10 volume %. When concentration of above-explained fluorine containing gas happens to be under 0.01 volume %, reaction speed of fluorine declines; and when it happens to exceed 10 volume %, discharging plasma would not generate even when high voltage is applied; and therefore, it is limited to the range explained above. It is preferable when it is 0.1 ~5 volume %.

[0013]
According to this invention, application of voltage is conducted under 100 ~ 800 Torr pressure in an atmosphere of above-explained fluorine containing gas and above-explained inert gas mixture. When it happens to be under 100 Torr, fluoridation does not sufficiently proceed; and even when it happens to exceed 800 Torr, effects remain unchanged to load on the device becomes greater, and therefore, it is limited to above-explained range. In particular, 700 ~ 780 Torr with ease of pressure adjustment and simplified device is recommended.

[0014]
In order to fluorinate the backbone surface of above-explained three-dimensional mesh-form porous material, although it is all right to heat or cool above-explained three-dimensional mesh-form porous material, room temperature is also adequate. Treatment time for fluoridation is sufficient when it is about 5 seconds.

[0015]
Method of manufacturing filter[s] of this invention is explained with reference to attached Figure 1. The Figure 1 illustrates a schematic cross section of atmospheric pressure plasma surface treatment device that is used in this invention. This device is composed of a power supply part (1), treatment container (2), upper electrode (4) and lower electrode (5). Although the power supply part (1) is capable of applying voltage of kHz level frequency, low frequency of 5 ~ 3- kHz is recommended for fluoridation of said three-dimensional mesh-form porous material that shows low heat resistance.

[0016]
As for the material of treatment container (2), no particular restrictions are placed as long as it can provide insulation against electrodes; and for instance, containers made of metals such as stainless, or aluminium and the like may be mentioned; and in particular, Pyrex glass made container is recommended.

[0017]
A pair of opposing parallel plate of upper electrode (4) and lower electrode (5) are arranged within a treatment container (2). As for the structure of said electrodes, besides parallel plate type, the one formed of cylindrical shape with opposing plate type, spherical shape with opposing plate type, opposing hyperbolic plane type, coaxial cylindrical type, or the one comprising plural numbers of fine wires may be used.

[0018]
Although materials for upper electrode (4) and lower electrode (5) are not particularly restricted , for instance, the ones made of multicomponent metals such as stainless or brass and the like; or pure metals such as copper or aluminium and the like may be mentioned.

[0019]
Solid dielectric (6) is arranged on lower electrode (5) at the plane opposite to the upper electrode (4); and surface treatment part (3) by discharging plasma is formed between both. Although discharging plasma generates by applying voltage to opposing voltage, it is recommended to apply voltage in such manner so the field strength would be about 5 ~ 40 kV/cm. When field strength happens to be under 5 kV/cm, plasma density and bias become small to require time for the treatment and is inefficient; and when it happens to exceed 40 kV/cm, solid dielectric becomes high temperature to show a behavior of shifting toward arc discharge.

[0020]
The solid dielectric (6) is arranged to cover an entire plane of lower electrode (5) that is opposite against upper electrode (4). When there happens to be partially not covered portion, arc discharging occurs from that portion, and is not desirable. It is all right when solid dielectric (6) is arranged on at the least one opposing plane of either upper electrode (4) or lower electrode (5).

[0021]
As for the material for said solid dielectric (6), for instance, plastic such as polytetrafluoro ethylene, polyethylene terephthalate, polycarbonate, or polyacrylate and the like; or ceramic such as aluminium oxide, titanium oxide, titanium dioxide, or barium titanate and the like may be mentioned.

[0022]
As for the shape of solid dielectric (6), it may be of either sheet form or film form. It is preferable when thickness is 50 µm ~ 4 mm although it depends on the material. When the thickness happens to be under 50 µm, insulation breakdown occurs during high voltage application to tend to cause arc discharging; and when it happens to exceed 4 mm, it is difficult to cause discharging.

[0023]
The fluorine containing gas is supplied from the upper electrode (4) through reaction gas induction tube (8), and inert gas is supplied through inert gas induction tube (9) to each surface treatment part (3). The fluorine containing gas and inert gas is controlled for their flow rate with a mass flow controller and are supplied as a mixture of gas of 0.01 ~ 10 volume % fluorine containing gas and 99.99 ~ 90 volume % of inert gas.

[0024]
Although it is preferable when upper electrode (4) is of a porous structure in order to supply fluorine containing gas to a surface treatment part uniformly to conduct said treatment with excellent uniformity, it does not need to be of said porous structure when, for instance, fluorine containing gas is supplied in a stirred state of gas, or gas is sprayed at high speed to allow uniform supply of the fluorine gas containing gas to the surface treatment part (3).

[0025]
The backbone surface of three-dimensional mesh-form porous material is fluorinated by contacting discharging plasma that generates through application of voltage to opposing electrodes under 100 ~ 800 Torr pressure in above-explained gas mixture with the three-dimensional mesh-form porous material (7) that is attached to the solid dielectric (6).

[0026]
The distance between upper electrode (4) and lower electrode (5) may be appropriately determined in accordance with thickness of solid dielectric (6), thickness f three-dimensional mesh-form porous material (7), level of applied voltage, and flow rate of fluorine containing gas; and it is preferable when it is between 1 ~ 20 mm; and when it happens to be under 1 mm, it is difficult to form a space causing amount of not-used gas to increase, and is not efficient; and when the distance happens to exceed 20 mm, uniformity of discharging plasma is tend to be damaged. Excess fluorine containing gas and inert gas are discharged from an gas outlet (10) of the container. Furthermore, when introducing gas for treatment or inert gas to the treatment container (2), it is recommended that the air remaining in the treatment container (2) is exhausted from the exhaust port (11).

[0027]
[EXAMPLES]
This invention is explained below in further details with examples; however, this invention should be limited to these examples.

[0028]
EXAMPLES 1 ~ 5
An atmospheric pressure plasma surface treatment device)metal made electrode diameter 120 mm) illustrated in the Figure 1 was used; and in a space between electrodes with 10 mm distance between electrodes within a treatment container, a nonwoven cloth made of polypropylene (made by Nippon Byleen K.K. [transliteration] with 10 mm diameter x 5 mm thickness was placed on a lower electrode to which a solid dielectric with 140 mm diameter x 2 mm thickness described in the Table 1; and inside of the treatment container was exhausted to 1 Torr.

[0029]
Fluorine containing gas and inert gas having the composition shown in the Table 1 were introduced to above-explained treatment container; and pressure was set to 758 Torr, and voltage of 15 kHz was applied, and this was left undisturbed for 15 seconds. Along with application of voltage, light emission due to discharging plasma was confirmed. When water was dropped on the post-treated nonwoven cloth, it was confirmed that the water was repelled to indicate its conversion to water repellency.

[0030]
Test explained below was conducted to compare the effects of fluoridation treatment. The treated nonwoven cloth was immersed in 1 Liter purified water in which 300 g of carbon black was dispersed to adhere carbon black; and after it was dried for 1 hour at 60°C, it was washed with ultrasonic wave in purified water for 10 minutes in order to wash adhered carbon black.

[0031]
Then, said nonwoven cloth was taken out to measure transmission rate of washing water. When a large amount of carbon black adhered to the nonwoven cloth was washed [off], due to presence of large amount of carbon black dispersed in washing water, turbidity and transmissivity of washing water shows low value, and with decline in washing effect, amount of carbon black dispersed in the washing water decreases and transmissivity shows high value. Immersion/washing (use new washing water at each occasion) was repeated until transmissivity reached 50% to record repeat frequencies in the Table 1.

[0032]
COMPARATIVE EXAMPLE 1
The same test as explained in the example 1 was conducted without treating nonwoven cloth made of polypropylene that was used in the example 1. Results are shown in the Table 1.

[0033]
[Table 1]

	fluoridation conditions			contamination test
	gas composition	solid dielectric	applied voltage	
example 1	CF_4 20 sccm He 980 sccm	silicon dioxide	7.0 kV	7 times
example 2	CF_4 10 sccm He 990 sccm	silicon dioxide	7.4 kV	6 times
example 3	C_3F_6 5 sccm He 995 sccm	titanium dioxide	5.0 kV	7 times
example 4	CF_4 20 sccm He 980 sccm	silicon dioxide	5.5 kV	5 times
example 5	CF_4 20 sccm He 980 sccm	polytetrafluoro ethylene	8.1 kV	5 times
comparative example 1	—	—	—	2 times

[0034]
[EFFECTS OF THIS INVENTIONA]

The filter that is manufactured by this invention's method of manufacturing filter[s] is fluorinated for the backbone surface of three-dimensional mesh-form porous material having through pores ; and it is possible to easily remove dirt to enable its reuse. In particular, it can be favorably used as a filter for ventilation machinery and equipment that is installed at the location where oil soot generates such as kitchen, or at vent port of ventilation and the like.

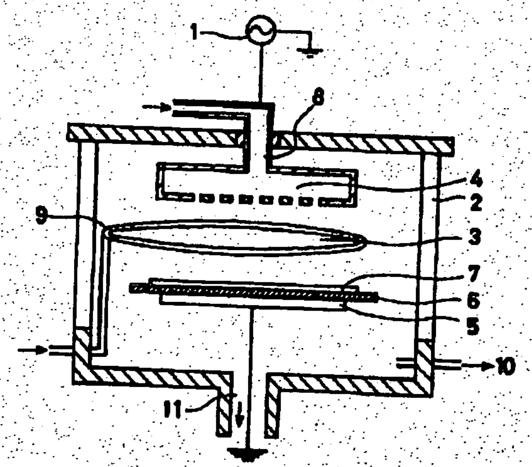
[BRIEF EXPLANATION OF THE FIGURE]
[FIGURE 1]

It shows a schematic cross section of a device used in this invention.

1	power supply part
2	treatment container
3	surface treatment part
4	upper electrode
5	lower electrode
6	solid dielectric
7	three-dimensional mesh-form porous material
8	reaction gas induction tube
9	inert gas induction tube
10	gas outlet
11	exhaust port

Figure 1

【図1】



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